ANNUAL REPORT

The Water Budget

Prepared by

Mark Maher
Fisheries Integration Branch
Division of Fish and Wildlife
Bonneville Power Administration

Submitted to
Northwest Power Planning Council

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Bonneville Power Administration

WATER BUDGET

ANNUAL REPORT

to the

Northwest Power Planning Council

Purpose

This report is written in response to the Northwest Power Planning Council's (Council) Columbia River Basin Fish and Wildlife Program (Program), Section 1500, Action Item 33.2. This Action Item requests that Bonneville Power Administration (BPA) continue to fund research and monitoring and to report on activities by November of each year. BPA has expanded this reporting requirement to include:

1. background and history of the development of the Water Budget concept including a discussion of Water Budget manager positions;
2. implementation of the Water Budget since it's formulation by the Council in 1983;
3. a discussion of the research and monitoring funded by BPA; and
4. a discussion of Section 304 of the Council's Program.

This is the first report on the Water Budget by BPA and encompasses the first three years (1983, 1984, and 1985) of operation.

Introduction

Development of dams on the Columbia and Snake Rivers has changed both the magnitude and timing of the spring flows. These flow changes have directly affected the travel time of migrating juvenile salmon and steelhead in their journey to the ocean. Historically, this migration to the sea took only two to seven days and occurred with the spring freshet (1). In the 1970's, spring flows changed somewhat dramatically with the completion of the major headwater storage projects. Man then had the capability to control runoff such that flooding could be prevented and the stored water could be released to meet the needs for electricity, irrigation and recreation. While the ability to control flows proved to be beneficial, especially to flood control and power generation, it adversely affected the annual salmon and steelhead downstream migration. The operation of the headwater storage reservoirs like Libby, Hungry Horse and Brownlee changed the seasonal timing of the runoff by storing the large peak flows for release later in the year when needed for electrical generation and irrigation. Therefore, these storage reservoirs reduced the magnitude of spring flows. The run-of-the-river projects such as Lower Granite, Priest Rapids and Bonneville created ponds in the river channe which, because of their increased volume, slowed the travel time of the migrating fish. Additionally, these pools created habitat for salmonid predators. The combination of seasonal and run-of-the-river projects increased the travel time for the downstream migrants from the two to seven day range to over 30 days from spawning grounds/hatcheries to the estuary.

This increase in travel time resulted in increased mortality by allowing additional exposure of migrants to predators which reside in the run-of-the-river reservoirs, and other detrimental factors.

As part of it's Fish and Wildlife Program, the Council sought to reduce the mortality associated with downstream migration by increasing the spring flows. The Council requested and received recommendations which were keyed to water year runoff volume. This "sliding scale" approach suggested reduced flows during some periods in years of low runoff and increased flows in years of high runoff. The Tribes suggested "optimum" flows every year timed to fish movement. Both bodies recommended fish flows be under the control of the fishery agencies and Tribes. A Water Budget volume concept was derived by the Council from the agencies' and Tribes' recommendations and water volumes were specified for the mid-Columbia and the lower-Snake Rivers. The Council recognized the fishery agencies and Tribes lacked the expertise to work effectively with owners and operators of the hydrosystem to implement the Water Budget. The fishery agencies and Tribes needed hydrosystem expertise to assure that the Water Budget would be considered in all phases of system planning and operation. To assist, the Council specified that Bonneville fund two Water Budget managers, one each representing the Tribes and fishery agencies.

The Council also recognized that data was lacking to justify their specified Water Budget volumes, so they requested BPA to fund Water Budget effectiveness

studies. The fishery agencies derived a flow-survival relationship from research data by the National Marine Fisheries Service (NMFS) (2)(3) to justify their need for flows. This relationship, plotted in Figure 1, is highly dependent on two data points - 1973 and 1977. Without these two points there would be no flow-survival relationship. Since the confidence of these data points is unknown, the Council specified flow-survival studies be conducted to verify the fishery agencies' assertions. These effectiveness studies are in addition to the monitoring required by the managers to implement the Water Budget and to communicate spill requests. BPA views the effectiveness studies as the vehicle to not only evaluate the size of the existing Water Budgets, but also to evaluate the operations of BPA, the U.S. Army Corps of Engineers (Corps), and the Water Budget managers.

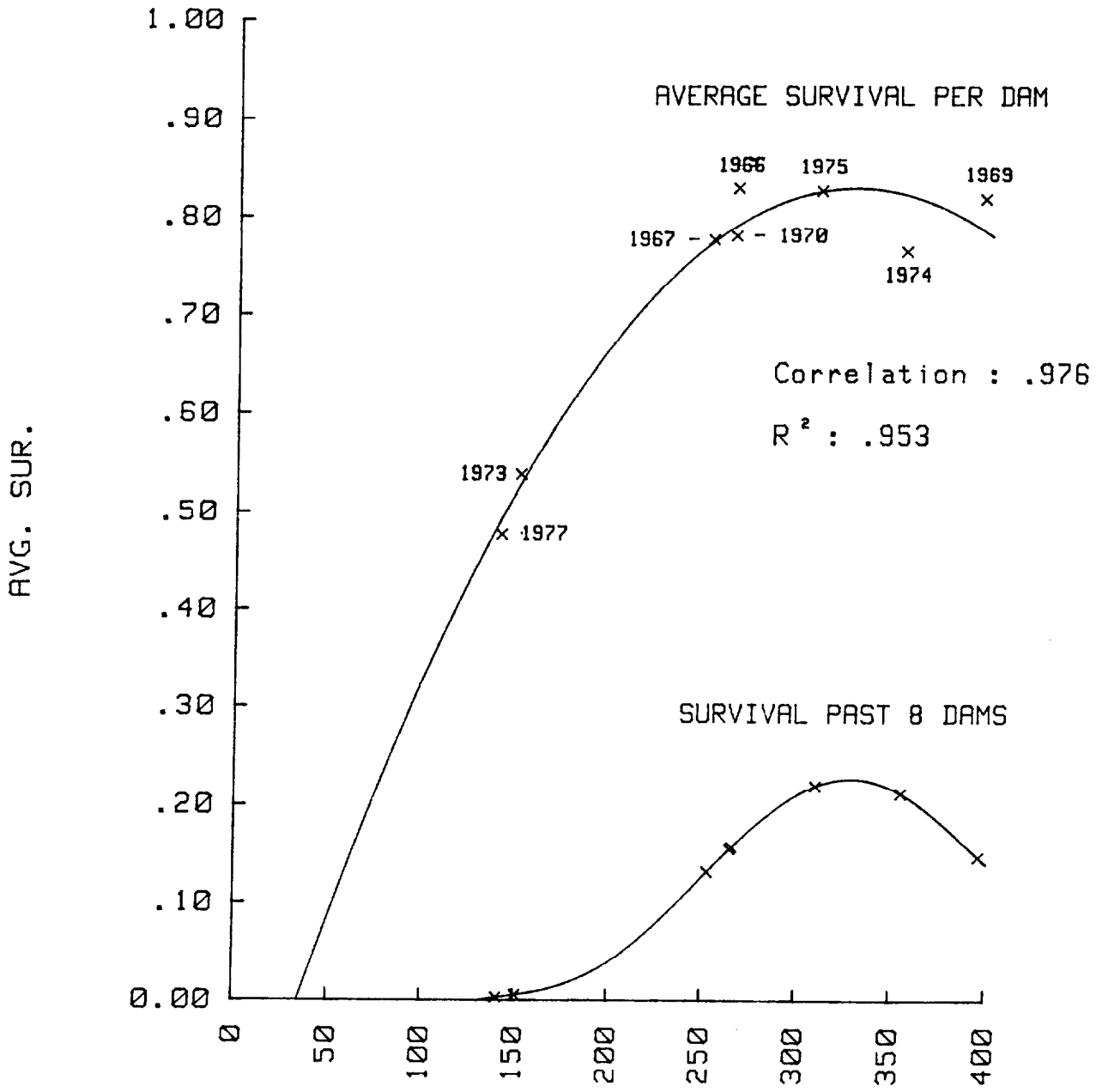
In summary, the Council formulated Water Budgets for the mid-Columbia and Snake rivers requiring BPA to fund Tribal and agency managers to implement the Water Budget and specifying that monitoring and effectiveness studies be conducted.

Implementation of the Water Budget

The first spring's operation under the Program occurred in 1983. However, the Water Budget was not an integral part of the coordinated system plan for that year because power operations planning occurs one year prior to actual implementation. The Water Budget was first integrated into the planning process in 1983 for implementation in 1984. Fiscal Year 1983, however, did

Figure 1.

ESTIMATED SURVIVAL FOR AVERAGE MAY FLOWS



afford all parties the opportunity to test the process of implementation. The test year of 1983 revealed problems such as the methods of accounting and daily or weekly implementation that are symptoms of a program measure that was not well defined. Similar problems surfaced in 1984 and 1985 even though all parties involved participated in advanced planning with the Corps in the development of its Annual Plan of Operation.

Figures 2 through 7 illustrate the Water Budget flows requested and the flows received for 1983, 1984 and 1985 at Priest Rapids and Lower Granite dams. Figures 2 and 3 are included for 1983 at Priest Rapids and Lower Granite to illustrate that Water Budget flows were met without holding the specified volume in storage through the previous fall and winter due to good water conditions. Figures 4 and 5 illustrate the requested and actual flows for the first year of the Water Budget. At Priest Rapids (Figure 4), there are apparent "misses" in meeting the requested flows, however, the weekly average flows were met during the period. There was only one weekend in May (Memorial Day weekend) where flows dipped below the request. This problem was solved in 1985 by providing additional protection for weekend flows.

In 1985 the runoff in the Snake River (Figure 7) had a pattern of high flows early in the spring with no precipitation in the spring and summer. The result was that flood control operations evacuated space in both Brownlee and Dworshak reservoirs prior to spring migration and natural runoff did not materialize in sufficient amounts or times to meet the apparent needs of the migration. While the fishery agencies and Tribes have complained that Water

Figure 2. Flows at Priest Rapids dam in 1983.

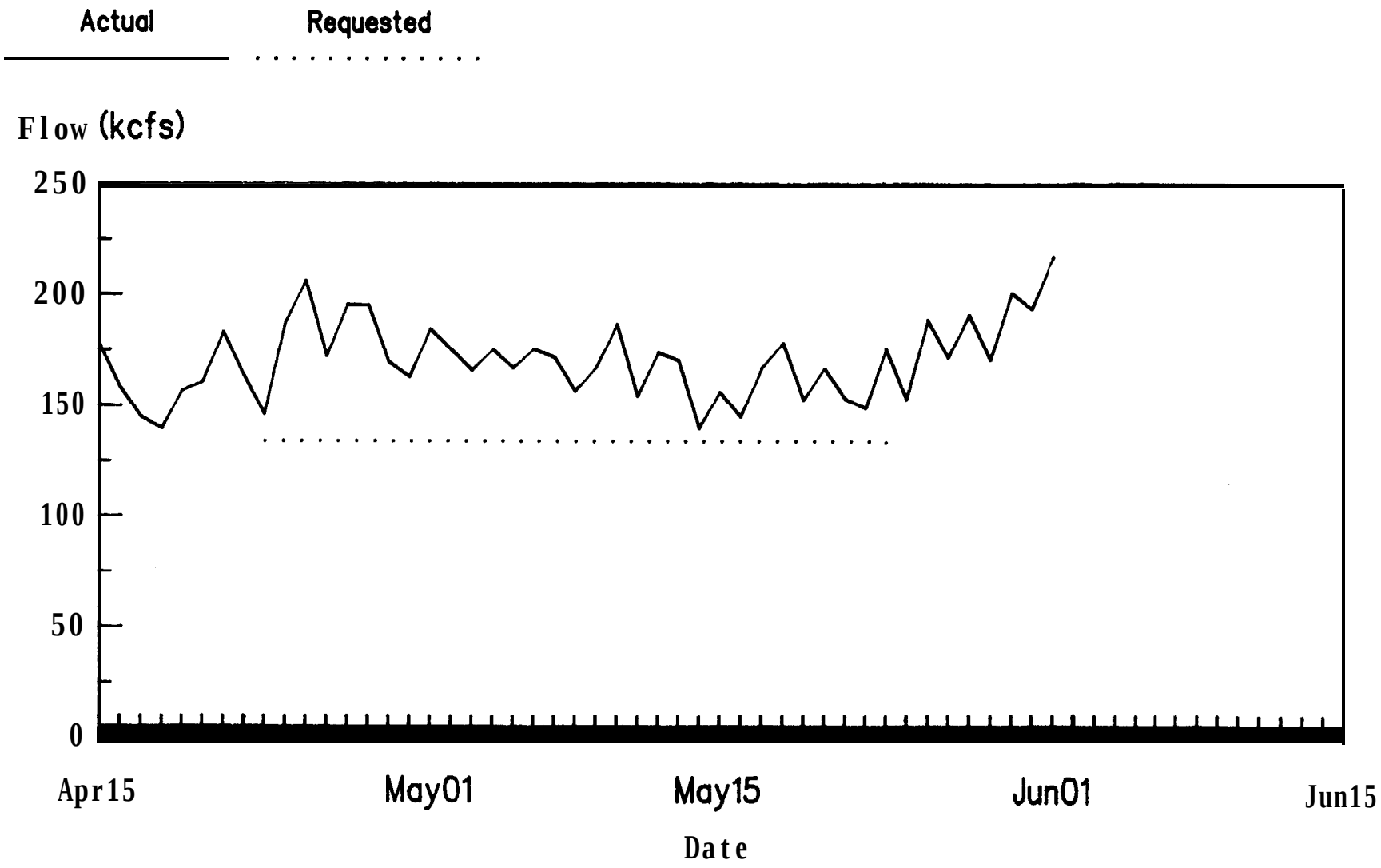


Figure 3. Flows at Lower Granite dam in 1983.

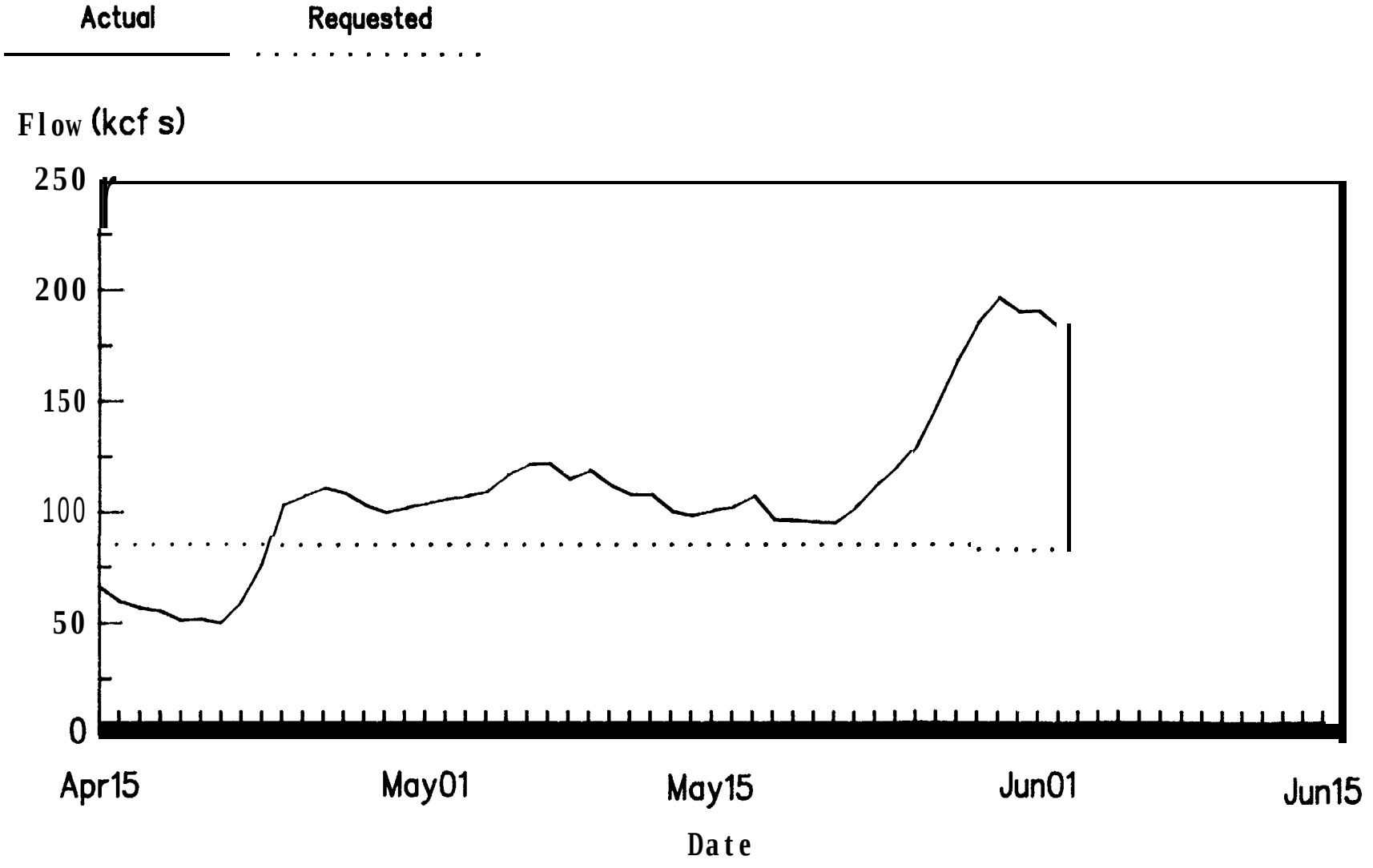


Figure 4. Flows at Priest Rapids dam in 1984.

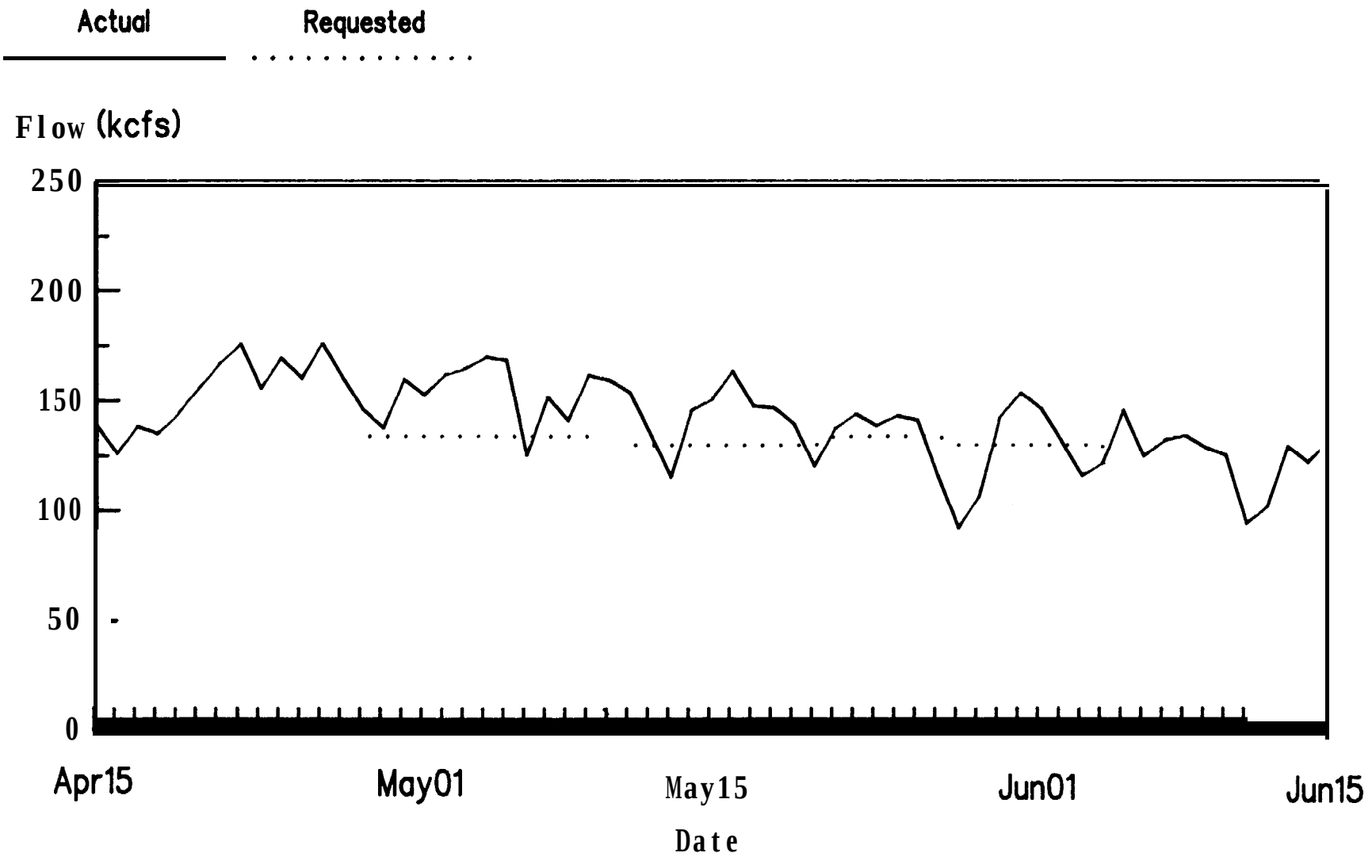


Figure 5. Flows at Lower Granite dam in 1984.

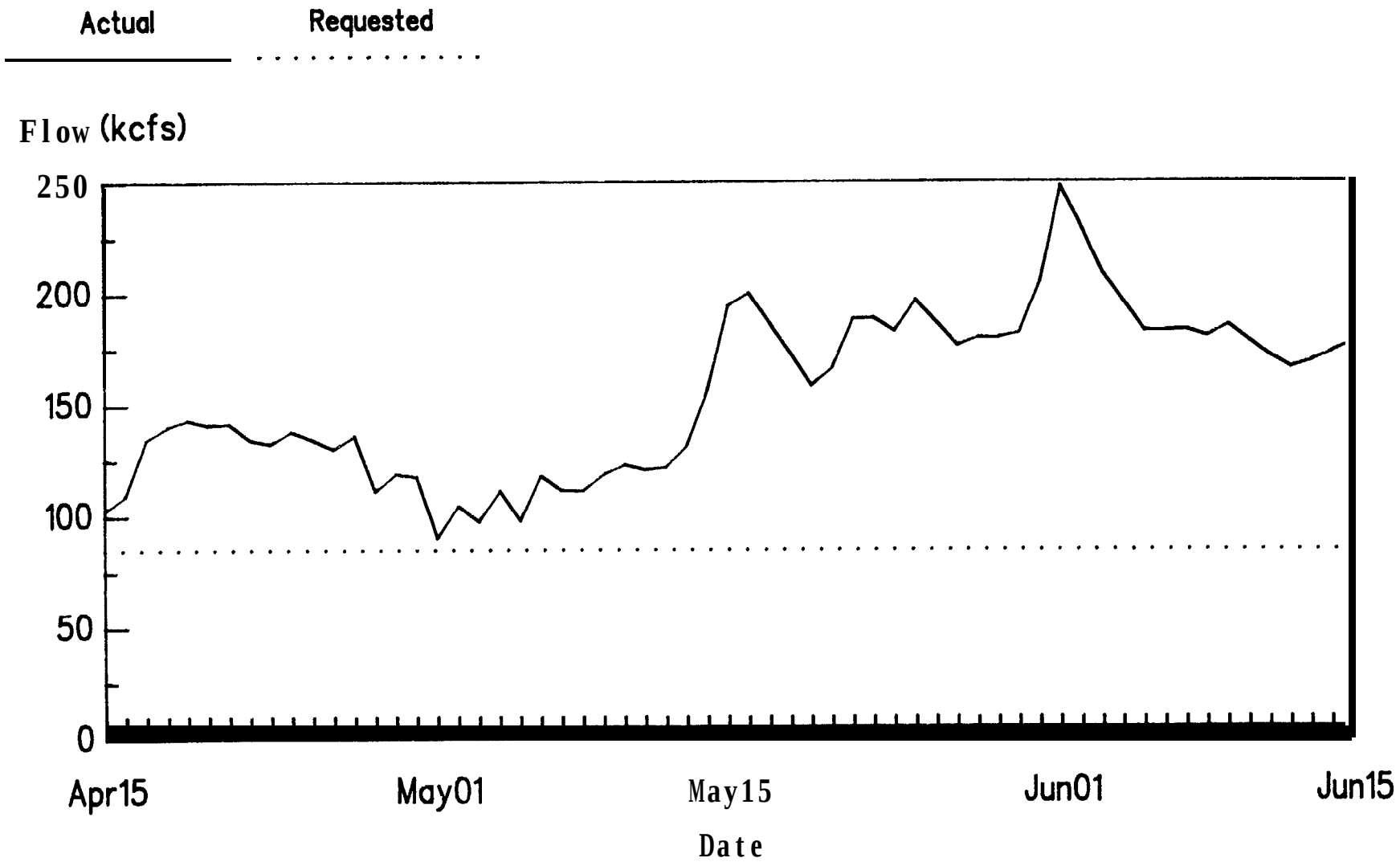


Figure 6. Flows at Priest Rapids dam in 1985.

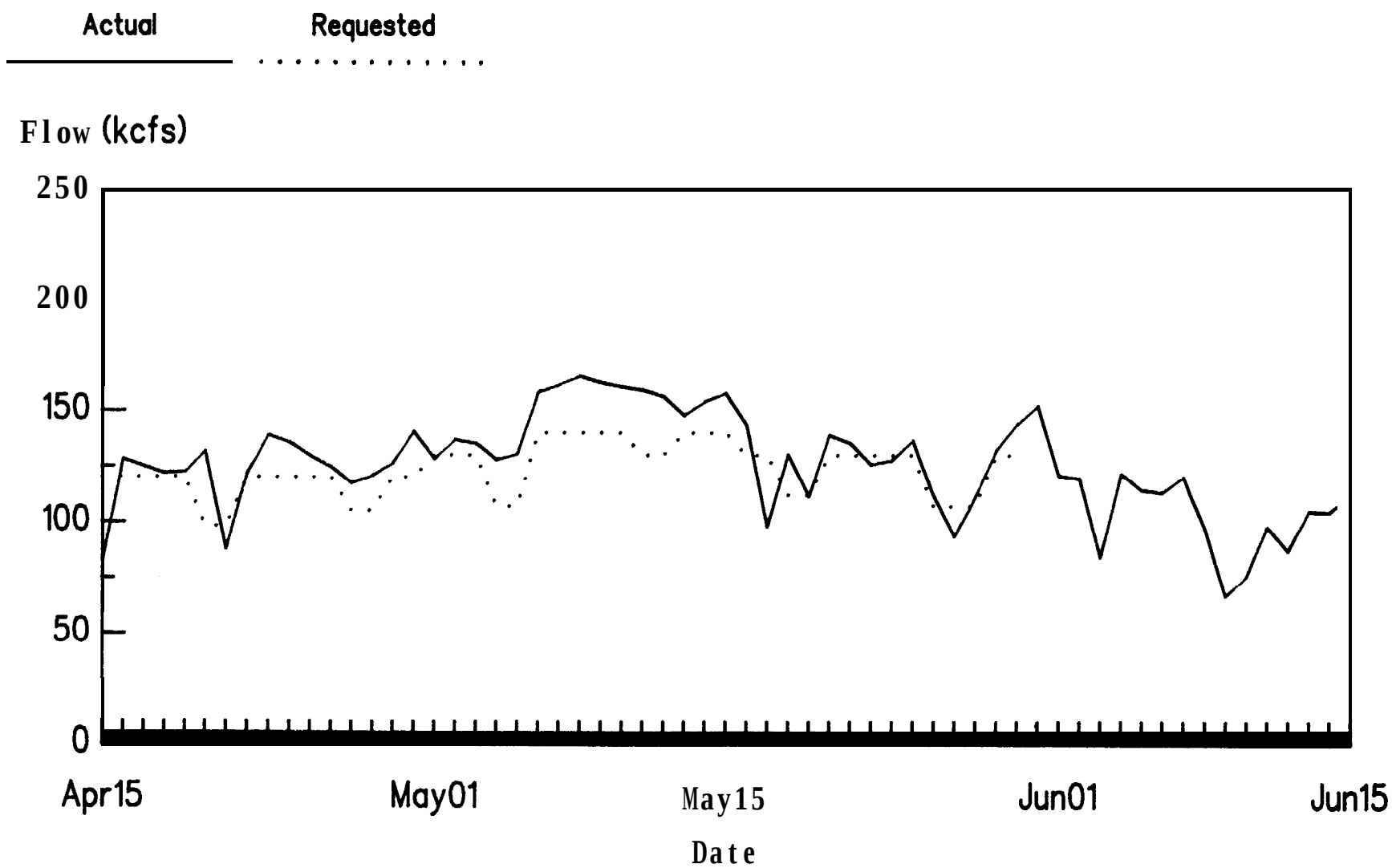
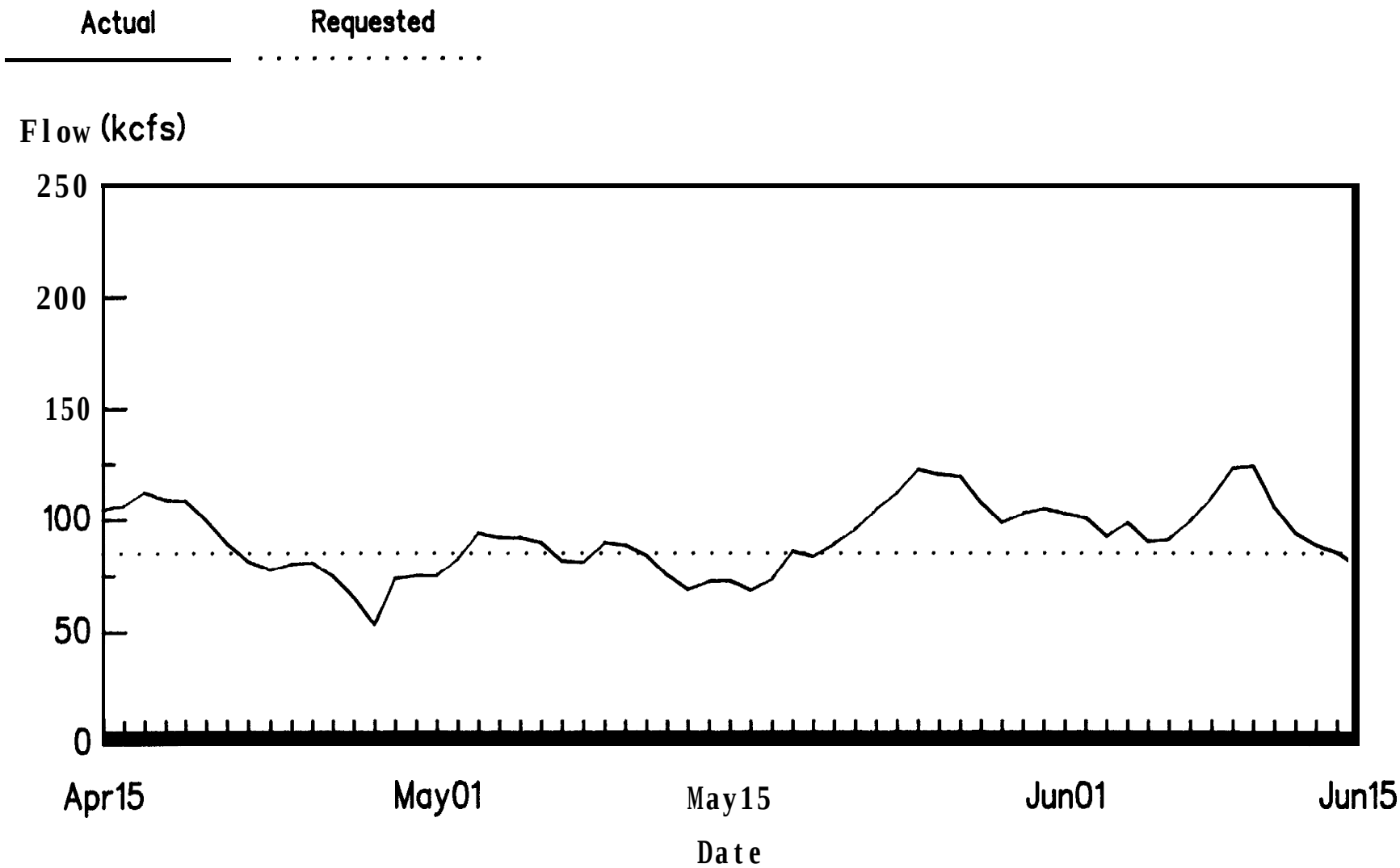


Figure 7. Flows at Lower Granite dam in 1985,



Budget flows were not met for 22 days, the real problem was that an unnatural runoff pattern presented an extremely low volume (82 percent of 20 year average 1961-80). The maximum amount of storage available in the Snake system for all uses including Water Budget is only three million acre feet (MAF) (1 MAF in Dworshak and 2 MAF in Brownlee). The average annual runoff in the Snake is 30 million acre-feet. In 1985, the January – July runoff was 25.2 MAF. None of this was from storage, as discussed above, because of flood control operations. Overall, the Water Budget has been provided as planned and successfully implemented.

The revenue losses due to actual implementation of the Water Budget and storage operations conducted each year prior to the Water Budget season were $12,687,000 in 1983-84 and $16,899,523 in 1984-85. Total revenue losses for the report period were $29,586,523.

Monitoring and Research Projects Funded in Support of the Water Budget

BPA has been funding the fishery agencies and Tribes since 1980 to assist them in managing and coordinating the outmigration of salmon and steelhead. During the period 1980 - 1982, BPA supported the activities of a Smolt Monitoring Coordinator and a Field Operations Coordinator. Total expenditures for these three years of this activity was over $315,000. The products received from these contracts were the agencies' input to the annual reports of the Council on Fishery Operations (COFO), a subgroup of the Columbia River Water Management Group. With the passage of the Pacific Northwest Electric Power

Planning and Conservation Act in 1981 and the subsequent issuance of the Council's Program, COFO disbanded. In 1983, the fishery agencies and Tribes organized the Water Budget Center to coordinate their activities associated with downstream migration activities in the Program.

The following list describes in brief the projects funded by BPA in direct support of the Water Budget managers:

1. Project 80-l - Smolt Monitoring Program. - Fishery Agencies and Tribes.
2. Projects 83-491 & 83-536 - Water Budget Managers - Fishery Agencies and Tribes.
3. Project 84-17 - Freeze Branding of Steelhead and Chinook Salmon Juveniles for Water Budget Studies. - Idaho Department of Fish and Game.
4. Project 83-323 - Smolt Condition and Timing of Arrival At Lower Granite Reservoir. - Idaho Department of Fish and Game.
5. Project 84-14 - Monitoring of Downstream Salmon and Steelhead Trout at Federal Hydroelectric Facilities. - National Marine Fisheries Service
6. Project 83-6 - Operation and Maintenance of BPA Fish Marking Trailer - U.S. Fish and Wildlife Service.
7. Project 86-60 - Downstream Migrant Monitoring - National Marine Fisheries Service.
8. Project 86-119 - Freeze Branding Salmon and Steelhead Trout at Lyons Ferry Fish Hatchery - Washington Department of Fisheries.
9. Project 84-54 - Juvenile Salmonid Monitoring at Rock Island Dam Bypass - Chelan County Public Utility District.

Project summaries contained in Appendix A are brief reports of activities since 1983. The reader should refer to the specific reports cited in these summaries for complete information.

In summary, BPA has funded ten projects since 1980 with a total cost to the ratepayers of $5,837,670 in support of the Water Budget Managers and Smolt Monitoring programs. Table 1 summarizes the funding provided by BPA for all projects associated with fish passage, by year, since 1980. Figure 8 illustrates the increases in funding year by year since 1980.

Table 1. SMOLT MONITORING – WATER BUDGET MANAGERS

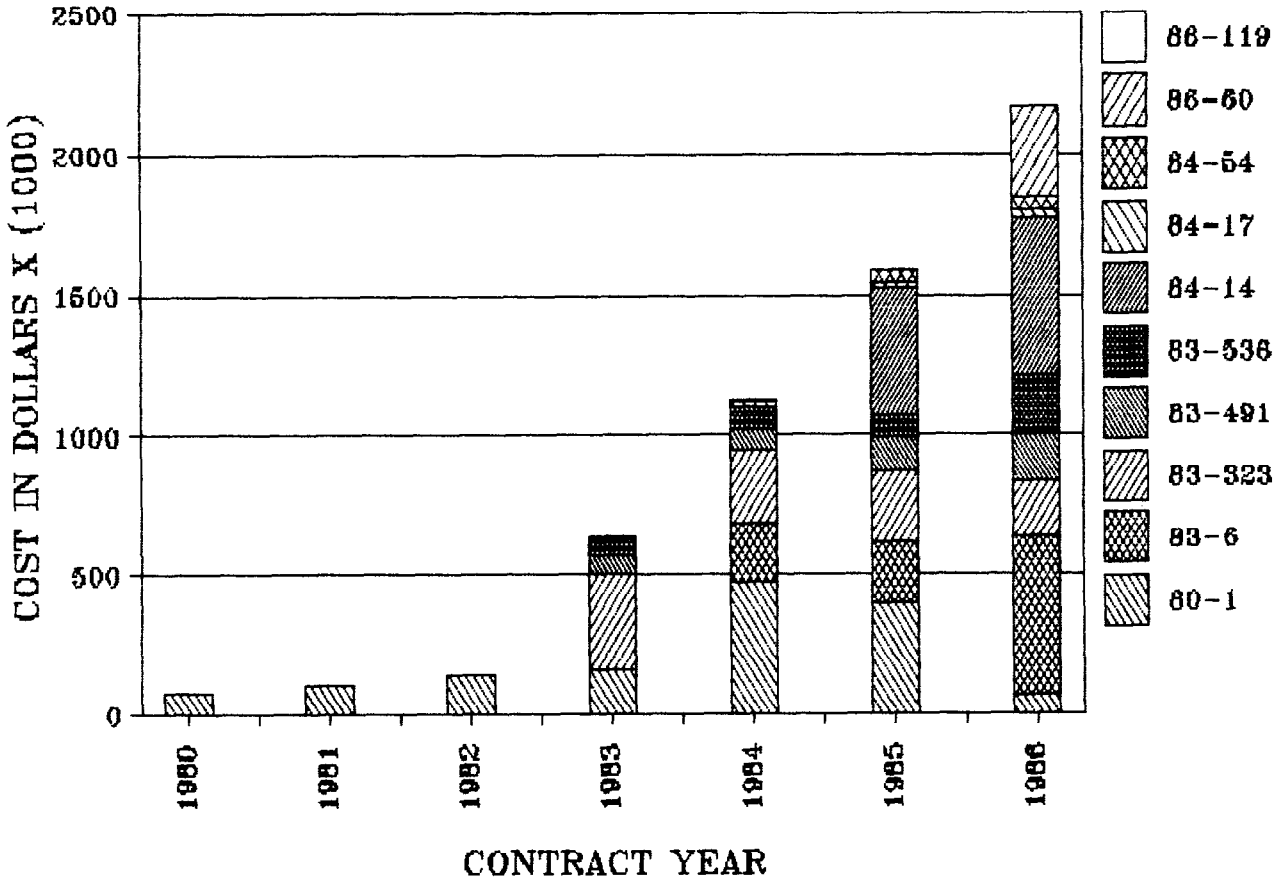
Dollars Expended

PROJECTS

YEAR	80-1	83-6	83-323	83-491	83-536	84-14	84-17	84-54	86-60	86-119	TOTAL
1980	75,975										75,975
1981	101,271										101,271
1982	137,842										137,842
1983	159,769		338,600	67,500	69,000						634,869
1984	477,507	203,800	261,617	74,794	79,376		19,800	4,979			1,121,873
1985	400,278	214,170	261,100	119,161	76,403	453,376	17,000	51,722			1,593,210
1986	64,566	567,613	201,993	173,340	204,066	562,413	23,800	51,359	317,155	7,128	2,172,633
TOTAL	$1,417,208	$985,583	$1,063,310	$434,795	$428,845	$1,015,789	$59,800	$108,060	$317,155	$7,128	$5,837,673

Figure 8.

SMOLT MONITORING – WATER BUDGET



Discussion of Program Measure – Section 304

(a.) Establishment and Use of the Water Budget

With the demonstrated history of the same recurring problems in accounting and implementation of the Water Budget, BPA has analyzed the Program Measure 304 and formulated recommended changes and clarifications. The following is a discussion of some of the section 304 "Measures". This discussion includes specific language of the subsection followed by recommendations for suggested modifications to clarify and strengthen the Program.

Section 304(a)(2):

> "To provide a base from which to measure Water Budget usage, the Council has established the 'firm power flows' listed in Table 1. Water budget managers will request flows for Priest Rapids and Lower Granite dams and dates on which these flows are desired. The flow requests must be greater than the firm power flows and less than 140 kcfs. Water Budget usage will be measured as the difference between the actual average weekly flows, which result from the Water Budget managers' requests, and the firm power flows.

Table 1

	Priest Rapids	Lower Granite
April 15 through April 30	76	50
May 1 through May 31	76	65
June 1 through June 15	76	60

"

Discussion: Section 304(a)(2) has caused endless debate between the fishery agencies and Tribes and the owners and operators of the projects on usage and accounting for the Water Budget in the mid-Columbia. The Council needs to specify very explicitly how the managers can request flows from the volume in storage. The agencies and Tribes have tried to implement the Water Budget on a daily basis which has hindered planning by the other parties. There has been no evidence that providing flows on a weekly average basis provides less protection for the downstream migrants than on a daily basis. The physical difference is that weekly average flows would allow higher flows during the week and lower flows on the weekend. Daily average flows would keep flows constant every day during the week. To address the effects of weekly versus daily flows, BPA proposes to solicit proposals in 1987 to examine the effects of short term flow fluctuations.

To overcome this difference the Corps, BPA and the Water Budget managers agreed in 1986 to a methodology, suggested by BPA, whereby BPA and the Corps would develop average weekly flow estimates. The Corps provided the weekly flow estimates to the Water Budget managers on Wednesday for the upcoming Monday-Sunday period. The managers had 24 hours to decide if they wanted to augment the projected power and flood control flows with Water Budget. The Water Budget request, if made, was for a weekly average flow. To protect against the agencies and Tribes concern of large weekday to weekend fluctuations, BPA and the Corps guaranteed that the average weekend flow would be no lower than 80 percent of the preceding average five weekday flows, when the Water Budget was being implemented. Usage of the Water Budget would be

measured against the firm power flows specified for the mid-Columbia Water Budget. This is a good operations procedure until the daily-vs-weekly flow issue can be further researched. This issue should only be revisited by the Council when new data are available that indicate a change in operating procedures would benefit the migration.

Section 304(a)(3):

> "The federal project operators and regulators shall incorporate the Water Budget requirement in all system planning and operations performed under the Columbia River Treaty, the Pacific Northwest Coordination Agreement, all related rule curves, and in other applicable procedures affecting river operations and planning. All parties will act in good faith in implementing the Water Budget as a 'firm requirement'. The Council expects that in order to reduce power system effects, thermal plant maintenance will be moved into the April 15 to June 15 period. The fish and wildlife agencies and Tribes must give the U.S. Army Corps of Engineers (Corps) three days written notice of changes in the planned flow schedule under the Water Budget."

Discussion: The last sentence referring to the 3-day notification period can be deleted since implementation is covered in 304(a)(2) previously.

Section 304(a)(4):

> "The Water Budget is expected to result in an average annual loss of 550 megawatts (MW) of firm energy load carrying capability, which will be taken into account in the Council's energy plan as provided in the Act. The actual amount of power loss is dependent on actions taken by power managers to accommodate the Water Budget. Such actions may include extra-regional firm power exchanges and shifting of thermal plant maintenance schedules."

Discussion: This section should now be deleted since the Water Budget is now integrated into annual system planning by all parties.

Section 304(b) Water Budget Manager:

The Council, through its Fish and Wildlife Program established two Water Budget manager positions. One Water Budget manager was assigned to the State and Federal fish and wildlife agencies and one was assigned to the Columbia River Basin Indian Tribes. The Water Budget managers are to provide assistance to their respective Tribes and agencies in working with the power project operators and regulators to ensure that requirements for fish are made part of river system planning and operations. We understand the Council established two manager positions because the agencies and Tribes, when they submitted their flow recommendations, had radically different approaches to providing flows. The fishery agencies presented a sliding scale approach which would match flow requests to the annual runoff volume as well as the fish migration. The Tribes, however, recommended optimum flow levels every year to be applied when fish are migrating. Once the program was in place and the two managers worked together, it appears there were no disputes. Also, at the time the Council initially developed the Program, the fishery agencies and Tribes did not have a common forum to resolve disputes. The Council noted this by having BPA fund two Water Budget managers. This would not force an alliance by having the fishery agencies and Tribes sharing a Water Budget manager. Times have changed. The fishery agencies and Tribes have resolved their harvest issue differences through the U.S. –vs– Oregon process and the fishery agencies and Tribes now are developing a common forum, the Columbia River Fish and Wildlife Directorate.

BPA recommends that implementation of the Water Budget requires the funding of one Water Budget manager working for the fishery agencies and Tribes. The manager would provide the needed expert assistance to the Tribes and fishery agencies. Presently the positions are redundant and BPA has not seen a demonstrated need for two managers. The cost of providing two Water Budget managers is presently $150,000 per year for salaries, benefits and travel expenses. Given that BPA is expected to experience budget shortfalls for at least the next two to four years, this $94,800 per year could be better spent on priority issues that produce tangible products, such as fish.

Section 304(d) Research and Monitoring:

In Section 304(d), items (1) and (2) appear repetitive. Section 304(d)(1) states that BPA shall fund a Water Budget effectiveness study. The study is to gather additional evidence on the relationships among flow, spill, travel time and smolt survival. Based upon the results of the study, the Council will determine whether the Water Budget is successful and to what degree. Section 304(d)(2) contains many of the same requirements for study under the smolt monitoring program. Section 304(d)(2)(D) requires Bonneville to fund the fishery agencies and Tribes to provide information, among other things, for correlation of data on flows, smolt survival, and subsequent adult returns as a basis for adjusting Water Budget usage and mark and recapture studies to evaluate flow, spill and structural bypasses as a means of improving downstream migrant survival.

BPA has funded the fishery agencies and Tribes to perform Water Budget effectiveness and the smolt monitoring program. The fishery agencies and Tribes have chosen to have National Marine Fisheries Service-Portland and Idaho Department of Fish and Game, U.S. Fish and Wildlife Service and Washington Departments of Fish and Game to conduct the smolt monitoring program in conjunction with the Water Budget managers, who are conducting the Water Budget effectiveness studies.

BPA questions the performance of the Water Budget managers to date in carrying out the Water Budget effectiveness studies. The effectiveness studies conducted to date are downstream migrant reach survival studies.

Theoretically, the managers have divided the basin into three reaches; mid-Columbia which is from Wells to McNary, Snake from Lower Granite to McNary and lower-Columbia from McNary to Bonneville. The design is to measure survival for all major artificially produced (hatchery) salmon and steelhead stocks in each of the three reaches. Each year an "index" of survival would be derived from the mark and recapture studies. An index number is not an absolute indicator of survival, it this merely an indicator which can be used to compare survival from year to year for a particular stock to obtain general trends which may be used by the Council to gauge the success of its Program. It cannot be used to compare survival between stocks nor be used to examine Water Budget effectiveness. Bonneville believes with the use of appropriate technology such as the PIT tag, research studies can be designed and carried out with fewer fish than now being used to obtain reliable survival and population estimates.

Grouping of data points for "like" passage conditions would occur or be attempted after five to ten years of data were collected for each stock. Survival data would be grouped by similar spill and operating conditions if possible for each project in each reach. The survival data points could then be regressed against flows to obtain the needed flow-survival relationship for each reach. This design has serious flaws. Only if all previously stated conditions are similar will results likely be valid. The Water Budget is too expensive and too important to the fish to rely on such a tenuous study design. It is likely that the Water Budget managers, using their existing

Water Budget effectiveness study design will not be able to delineate flow effects by utilizing variations in spills due to confounding factors such as changing dam operating conditions, changes in fish health from year to year and a multitude of other variables.

BPA believes the managers should design and guide the smolt monitoring program to the extent that it provides them with accurate and timely data required to make real-time system operational requests for flows and spills. The Water Budget managers should not be performing Water Budget evaluation or any other research functions. We feel that well designed reservoir mortality studies will yield the type of information which is needed to examine Water Budget effectiveness. The Water Budget managers have a reporting requirement in their 1986 contract with BPA to develop a special report on Water Budget Evaluation, due on November 1, 1986. This report on Water Budget evaluation alternatives is to include:

1. Requirements and availability of test fish and recommendations for producing the needed fish;
2. alternate strategies for measuring effects of the Water Budget;
3. current limitations in measuring the Water Budget;
4. necessary design to achieve statistically significant results;
5. needed technological advances to achieve statistically valid evaluation; and
6. review process of fish and wildlife entities and project owners and operators.

BPA intends to utilize this report from the Water Budget managers as input when soliciting proposals to address Water Budget effectiveness. As stated earlier, the Water Budget is to correct for shifts in magnitude and timing of flows. Reservoir mortality studies are the measurements used to determine the magnitude of the problem plus the mechanism by which improvements are measured. However, reservoir mortality studies are only one component of Water Budget effectiveness. BPA feels that Water Budget effectiveness studies can be conducted in a more direct fashion with studies which would include reservoir mortality utilizing the PIT tag.

BPA also questions whether the Water Budget managers have needed the extensive smolt monitoring database to make real-time decisions implementing the Water Budget and communicating spill requests. For 1987, a total of 1.5 million fish are proposed to be marked at 13 hatcheries in the Snake and mid-Columbia rivers. Are these marks needed to turn on or modify the operation of the Water Budget? Are spill decisions actually made or modified based upon the arrival of certain brands on various stocks? The Water Budget managers have never justified the need for this large number of brands in their study designs or their annual reports. It appears to BPA that spill decisions are based primarily on the numbers of fish in real-time samples at specific dams and not on specific stocks of fish. Water Budget flows have been called for after sampling has shown that 10% of the migration has arrived at the first dams (Wells and Lower Granite) and the existing flows are below the agencies' and Tribes' minimum flow requirements. The Water Budget is then implemented

by augmenting forecasted flows until exhausted. The migration of individual stocks does not appear to be criteria for implementing or shaping Water Budget flows.

BPA strongly recommends that the Council re-examine Section 304(d)(l) and (2) to clarify their desires for Water Budget effectiveness.

Other Outstanding Issues Associated with Fish Passage:

The Corps has developed a useful modeling tool called FISHPASS. The Council has utilized this model through its Mainstem Passage Advisory Committee. A BPA contractor also utilized this model extensively in the development of a Potential Columbia River Fish Passage Plan which is scheduled for release in December, 1986. FISHPASS modeling by BPA, the Corps and the Council has shown that system survival, survival of a stock of fish from its point of entry on the mainstem to below Bonneville dam, is most dependent on reservoir mortality, transportation and turbine mortality.

Using the Corps' 1986 spill plan, assuming bypasses at all Federal projects and average water conditions, dam survival averaged 94.7 percent while average reservoir survival was only 83.4 percent in a recent FISHPASS study conducted by BPA. Further analysis of turbine and reservoir mortality were then conducted. Simulations were made with FISHPASS where reservoir mortality was held constant while turbine mortality was halved then doubled. There was no spill in these studies to examine the full effect of turbine mortality. Turbine mortality was then held to levels agreed upon in the Council's MPAC while reservoir mortality was halved and then doubled.

Finally, studies were run where turbine mortality was halved and reservoir mortality was doubled, and where turbine mortality was doubled while reservoir mortality was halved. Table 2 summarizes these studies in comparison to a study run using MPAC determined criteria. Extreme values were used for turbine and reservoir mortality since these parameters are critical to determinations of survival and there is wide variation among experimentally determined values for turbine and reservoir mortality[4].

(The following discussion is limited to spring Chinook). Variations in reservoir mortality produced a wide swing in survival of yearling Chinook. Other species will be reported on in the Potential Columbia River Fish Passage Plan[4]. Halving reservoir mortality nearly doubled survival (1.95 times survival in the base case). Doubling reservoir mortality dropped survival to about one fourth it's previous value (0.22 times the base case survival level). Changes in turbine mortality had a much less impressive effect on survival. Doubling turbine mortality dropped survival to 0.72 of the base value, while halving turbine mortality increased survival to only 1.17 times the base level. When decreases in reservoir mortality were coupled with increases in turbine mortality and vice versa, the result was a dampening of the swing produced by reservoir mortality alone. Decreased reservoir mortality with increased turbine mortality resulted in survival of 1.49 times the base level, a 46 percent reduction in survival from the effect of decreased reservoir mortality alone, but clearly a result in which reservoir mortality had a far more significant impact. In the case of increased reservoir mortality with decreased turbine mortality, survival is 0.25 times the base level, only 3.7 percent higher then seen with increased reservoir mortality due to decreased turbine mortality.

Table 2

Survival of Smolts from Lower Granite Dam Under Varing Assumptions, Water Year 1942

		Yearling Chinook Survival						
Project	Number of Smolts	MPAC Tur. and Reservoir Mortality	Reservoir Mortality Doubled	Reservoir Mortality Halved	Turbine Mortality Halved	Turbine Mortality Doubled	Tur. Mort Halved & Reservoir Mort. Doubled	Res. Mort Halved & Turbine Mot-t. Doubled
	To Dam	3739	3739	3739	3739	3739	3739	3739
Granite	Past Dam:	3518.8	3519.8	3518.8	3602.8	3350.7	3602.8	3350.7
Little	To Dam:	2843	2163.8	3197.1	2910.9	2707.2	2215.5	3044.4
Goose	Past Dam:	2690.3	2047.6	3025.5	2811.3	2456.3	2139.7	2762.3
Lower	To Dam:	2287.4	1442.3	2805.2	2390.2	2088.4	1507.1	2561.2
Monument	Past Dam:	2158.6	1361.1	2647.3	2305.8	1883.3	1453.9	2309.6
Ice	To Dam:	1806.4	924.8	2418.6	1929.6	1575.9	987.8	2110
Harbor	Past Dam:	1714.3	878	2294.9	1865.8	1439.1	955.3	1926.2
McNary	To Dam:	1461.6	625.1	2120.1	1590.7	1227.1	680.1	1779.5
	Past Dam:	1397	597.7	2026.1	1542.7	1138.5	659.7	1650.6
John	To Dam:	1027.8	287.7	1755.4	1134.9	837.8	317.4	1430.2
Day	Past Dam:	970.4	271.6	1657.3	1095	756.3	306.3	1290.9
The	To Dam:	884.5	277.9	1582.5	998	689.3	256.9	1232.7
Dalles	Past Dam:	826.7	213	1479.1	958.9	608.1	246.9	1087.5
Bonn.	To Dam:	700.4	151.2	1366.6	812.4	515.3	175.2	1004.9
	Past Dam:	673.3	6145.4	1313.5	789.8	484.2	170.4	943.9

Clearly, reservoir mortality is more significant than turbine mortality in determining the survival of chinook smolts through the system. This is in large part due to the assumption of bypass systems at all federal facilities in these simulations. However, since only a portion of the fish are affected by turbine mortality large changes in turbine mortality do not translate into large changes in system survival. However, reservoir mortality directly affects all fish and therefore, has a much greater influence on system survival.

The best way to avoid reservoir mortality is to remove the migrants from the reservoir. BPA believes that barge transportation of all stocks would be the best deterrent at this time to reservoir mortality. We feel that the transportation studies conducted to date and reported on by NMFS[5] clearly demonstrate that transportation works for all species. BPA believes problems with a potential differential survival that occur for spring chinook, are most likely from the prevalent disease problem inherent with these hatchery fish. BPA, therefore, strongly recommends expanding transportation studies to provide statistically reliable data and to continue work in the area of Bacterial Kidney Disease research. We also recommend an accelerated schedule for reservoir mortality research.

References

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4. Harper, R. 1986. - "Potential Columbia River Fish Passage Plan" - Unpublished, BPA

5. Park, D.L. 1985. A Review of Smolt Transportation to Bypass Dams on the Snake and Columbia Rivers. In: Comprehensive Report of Juvenile Salmonid Transportation. U.S. Army Corps of Engineers, Walla Walla District. Walla Walla, Washington. 66p.

APPENDIX A

PROJECT SUMMARIES

Project: Smolt Monitoring Program. BPA-80-l.

Program Measure: 304(d)(2)(A) & (E)

Contractors: Columbia River Fisheries Council (CRFC)
National Marine Fisheries Service (NMFS)
Columbia River Intertribal Fish Commission (CRITFC)
Pacific Marine Fisheries Commission (PMFC)

Project Manager: John Ferguson

Project Status: Ongoing; scheduled to continue.

Project Initiated: 1980

Project Cost: $1,417,208.00

Project Summary:

As a result of implementation of Section 304(d)(2) of the Northwest Power Planning Council (NPPC) Fish and Wildlife Program, an annual smolt monitoring program was initiated. The monitoring program provides information on migrating characteristics, estimates of survival and coordination of flow/spill with salmon and steelhead smolt migration timing.

Project Objectives:

1) To monitor movement of chinook salmon and steelhead trout smolts to determine best timing for storage releases;

2) To utilize mark and recapture studies to evaluate flow, spill, and structural bypass in order to improve downstream migrant survival;

Project Results

1984

Inspections were made of adult fishways at each of the Columbia and Snake River dams during 1984. In addition, on-site inspections of fingerling by-pass systems were made to determine that they were operating "in criteria", Overall, movement of upstream migrants appeared to be satisfactory in 1984 with the exception of summer steelhead which were delayed by temperature barriers or other factors. Problems also occurred when low tailwater conditions reduced head at main fishway entrances. Changes were made throughout the season to enhance passage of adults and juveniles.

Survival of steelhead trout from Wells Hatchery was studied to derive an index of steelhead survival for the Mid-Columbia. A survival index of 0.5181 (%0.0555) was estimated for steelhead from Pateros, Washington to below Priest Rapids dam. In 1985, study was expanded to include spring chinook in the mid-Columbia and steelhead in the Lower Snake River.

Travel time of marked yearling and sub-yearling chinook salmon, sockeye salmon, and steelhead was measured between points within the Columbia River system. Groups of marked yearling chinook exhibited migration speeds of 12.1 miles/day from Lower Granite dam to McNary dam. One group of steelhead traveled at a speed of 20 miles/day for the same stretch of river. In the mid-Columbia, yearling chinook salmon exhibited speeds of 10.8 miles/day from Winthrop Hatchery to McNary clam. Steelhead released at the Lower Methow River traveled 14.7 miles/day while steelhead released below Priest Rapids dam migrated 18.7 miles/day to McNary dam. Sockeye salmon traveled at the highest rate of 25.1 miles/day from Priest Rapids dam to McNary. In contrast, summer chinook released from Wells hatchery traveled at the slowest rate of 3.8 to 4.4 miles/day to McNary dam. In general, fish traveled at substantially higher rates in the Lower Columbia.

Passage of yearling chinook and steelhead peaked on 2 May and 15 May, 1984 respectively, while sockeye exhibited bi-modal peaking on 25 May and 13 June, 1984 in the Lower Snake River.

A total of 75.1 million steelhead and salmon smolts were released from hatcheries above Bonneville dam in 1984. Duration of the migration for chinook salmon and steelhead trout was 32 and 39 days, respectively.

1985

Extensive data was collected in 1985 relating to migrational characteristics of the Columbia River basin salmon and steelhead. This was accomplished in two parts:

Part I - described monitoring of survival of salmon and steelhead smolts on the mid-Columbia and lower Snake rivers to McNary;

Part II- described results of yearling salmon and steelhead travel time monitoring between specific points in the Columbia River basin.

Due to differences in flow between 1984 and 1985, travel time was generally faster in 1985 than observed times in 1984 in the index area. Survival of spring chinook through the mid-Columbia reach in 1985 was 45% (+22X) while steelhead survival was 65% (±26%) for the same reach. Data for steelhead suggested that survival estimates were possibly biased toward higher levels of survival as a result of higher incidence of burning from the branding operation.

Project:	Operation and Maintenance of BPA Fish Marking Trailer, BPA-83-6.
Program Measure:	Non measure
Contractor:	U.S. Fish and Wildlife Service
Project Manager:	John Ferguson
Project Initiated:	1983
Project Status:	Ongoing

Project Cost Summary:		
	1986	567,613
	1985	214,170
	1984	203,800
	TOTAL	985,583

Project Scope:

The U.S. Fish and Wildlife Service, under contract with the Bonneville Power Administration, utilizes a mobile fish marking unit to participate in marking programs conducted at fish hatcheries throughout the region. Marking consists of coded wire tagging with an adipose clip and/or freeze branding. The mobile unit has also been used to adipose-only clip Idaho hatchery steelhead for a program to differentiate between hatchery reared and wild stocks.

The project focuses primarily on marking for BPA funded activities, which include:

1. Water Budget smolt survival, smolt monitoring and travel time groups from various sources throughout the Columbia River Basin;

2. Passive Integrated Transponder (PIT) tag marking programs designed to facilitate the field evaluation of the PIT tag marking;

3. Spring chinook study by the Yakima Indian Nation for release at Leavenworth National Fish Hatchery; and

4. Pen rearing of upriver bright fall chinook at Rock Creek, Little White Salmon and Social Security Lake.

Project Objectives:

Specific objectives of the project are:

1. To operate and maintain the tagging trailers;

2. Give priority to BPA funded fish tagging projects;

3. Coordinate all fish tagging operations to include a tagging supervisor, fish taggers, transportation of the fish tagging trailer, equipment, and material purchases; and

4. Provide quarterly and annual reports to BPA. Annual report is due by December 31.

Project Results:

The U.S. Fish and Wildlife Service continues to professionally operate and maintain the BPA fish marking trailer, and mark a large number of fish (2,900,000) for a variety of projects accurately and in a timely manner, In 1986 they began to update the existing trailer to include PIT tags, and purchase and outfit two new trailers to accommodate the latest equipment and the increased work load.

Project: Smolt Condition and Timing of Arrival at Lower Granite Reservoir. BPA-83-323B.

Program Measure: 304(d)

Contractor: Idaho Department of Fish and Game

Project Manager: Tom Vogel

Project Status: Ongoing; scheduled to continue.

Project Initiated: 1983

Project Cost: $1,063,310.00

Project Scope:

The purpose of this project is to provide information on smolt movement from nine Idaho release sites entering Lower Granite Reservoir. This information will aid Water Budget Managers in providing the means to effectively manage river operations for protection of downstream migratory smolts.

Project Objectives:

1. To develop a technique to index the relative magnitude of smolt abundance at any given time at the upper end of Lower Granite reservoir;

2. To establish timing and success of outmigration for the various groups of hatchery and wild chinook salmon and steelhead smolts as they leave the Salmon River drainage;

3. To establish travel time from the Salmon River index site at Whitebird to the indexing site at the upper end of Lower Granite reservoir;

4. To correlate travel time with river flows from indexing sites to Lower Granite dam;

5. To assist in estimating total fish abundance and collection efficiency at Lower Granite dam;

6. To determine where, when and to what extent descaling occurs to salmon and steelhead smolts released from Snake River hatcheries above Lower Granite dam and develop management alternatives to correct the problem.

Project Results:

1983

Median migration release sites to Whitebird ranged from 4.4 to 10.7 miles/day for chinook released from Rapid River and Decker Flats, respectively. Using NMFS and IDFG data, travel time from Whitebird to Red Wolf bridge ranged from 7 to 35 miles/day. Arrival time at Lower Granite for branded hatchery chinook smolts ranged from 18 April to 4 May, 1983. Chinook from Kooskia NFH migrating in the Clearwater River to Lower Granite reservoir at the rate of 5.4 miles/day.

Dworshak releases of steelhead and chinook migrated down the Clearwater River to Lower Granite reservoir at 3.7 to 22 miles/day for steelhead, and 2.5 miles/day for chinook. Changes in water velocity, day length and transparency strongly influenced migration rates of Salmon River fishes.

Descaling rates ranged from 2-4% for chinook, l-5% for wild steelhead, and O-30% for hatchery steelhead. Larger smolts generally suffered higher descaling rates.

1985

One to three percent of hatchery produced fish from Clearwater, Salmon and Snake River drainages were freeze branded. Peak passage for chinook occurred from 10 April to 17 April, 1984 and from 17 April to May 12, 1984 for steelhead.

Median migration rates for chinook released at Whitebird traps and Hell's Canyon Dam ranged from 51 miles/day and 11 miles/day, respectively. Discharge was not significantly correlated with migration rates. Rate of migration through the reservoir dropped substantially to 1.9 miles/day.

Average trapping efficiencies were 1.24, 1.57 and 1.70% for Whitebird, Clearwater and Snake River traps, respectively. Trapping efficiency and discharge were not significantly correlated. Seasonal descaling rates for all fish ranged from 2.1 - 4.5% for the Whitebird trap, 1.4-5.5% for the Snake River trap, and 0.4-4.1% for the Clearwater trap. As seen in 1983, larger fish were descaled at higher rates.

Project: Water Budget Managers. BPA-83-491 and BPA-83-536.

Program Measure: 304(c) 3(A,B,C)

Contractors: Pacific Marine Fisheries Commission (PMFC)
Columbia River Inter-Tribe Commission (CRITFC)

Project Manager: John Ferguson

Project Status: Ongoing; scheduled to continue.

Project Initiated: 1982

Project Costs: 83-491 $434,795.00
83-536 $423,845.00

Project Scope:

The purpose of this project to provide agency and tribal Water Budget Managers to submit annual reports on the Columbia Basin Water Budget.

Project Objectives:

1) To report actual flows achieved for each calendar year;

2) To provide a record of the estimated number of smolts which passed Lower Granite and Priest Rapids dams and the period of time over which the migration occurred; and

3) To provide a description of flow shaping for each calendar year to achieve improved smelt survival during migration.

Project Results

1984

An unusually large runoff and sustained high level flows in the Snake River virtually eliminated the need for a Water Budget in 1984. Flows at Lower Granite dam were above the specified minimum throughout the Water Budget period (April 15 - June 15) resulting in favorable conditions for juvenile fish passage in 1984.

1985

During the 60 day budget period, flows at Lower Granite dam were below the specified minimum (85 kcfs) for nearly half the period. Flows for 1985 were consistently lower than 1984. Low flow conditions were a combination of 1) lower than average natural run-off, 2) early evacuation of Dworshak and Brownlee reservoirs based on early run-off forecasts, 3) Idaho Power Company's failure to make a pre-season commitment to provide supplemental flow from Brownlee, and 4) failure of the Corps of Engineers to utilize flexibility when providing additional flow from Dworshak. Recommendations were made by the Water Budget Managers to avoid such problems in the future.

Project: Monitoring of Downstream Salmon and Steelhead Trout at Federal Hydroelectric Facilities. BPA-84-14.

Program Measure: 304(d)

Contractor: National Marine Fisheries Service, Portland, Oregon.

Project Manager: John Ferguson

Project Status: Ongoing; scheduled to continue.

Project Initiated: 1984

Project Cost: $1,015,789.00

Project Scope:

The purpose of this project is to provide the Water Budget Center with salmon and steelhead smolt passage information on the Lower Snake River and mid-Columbia River.

Project Objectives:

1) To systematically sample migrating smolts at Lower Granite, McNary and John Day dams;

2) To recover and record brands on sampled fish at the dams;

3) To provide the Water Budget Center with a daily index of smolt passage at Lower Granite and McNary and daily sample numbers at John Day;

4) To provide the Water Budget Center with daily summaries of brand recapture data.

Project Results:

Sampling occurred from 28 March to 29 October, 1985. The number of fish sampled, total brands in sample, and estimated total number collected is listed by species in the annual report. Die1 passage provided by Bio-Sonics hydroacoustics unit indicated peak passage occurs at 0200 hours. Also included is chart of 'time-in-river system' for each species sampled. Recommendations called for coordination of all activities affecting sampling/monitoring, timely reporting of mark-release information to each sampling site and assurance of good quality branding.

Project: Freeze Branding of Steelhead Trout and Chinook Salmon Juveniles for Water Budget Studies - Idaho. BPA-84-17.

Program Measure: 304(d)

Contractor: Idaho Department of Fish and Game

Project Manager: John Ferguson

Project Status: Ongoing; scheduled to continue.

Project Initiated: 1984

Project Cost: $36,800.00

Project Scope:

To provide information on fish movement and run status for in-season operational management including Water Budget management and to investigate the relationship between flows, spills and smelt passage and survival.

Project Objectives:

To focus on releases of hatchery reared chinook salmon and steelhead trout that have been freeze branded as indicators of release groups and used to determine travel time in the Lower Snake River and Columbia River to McNary Dam.

Project Results:

A total of 362,428 chinook salmon and steelhead trout were freeze branded for the Water Budger Center. Following brand loss and mortality, a total of 320,000 marked fish entered the river system 106,361 of which received coded wire tags. Results on movement of these fish was not available at the time of this report.

Project:	Juvenile Salmonid Monitoring at Rock Island Dam Bypass, BPA-84-54
Program Measure:	304(d)
Contractor:	Chelan County P.U.D.
Project Manager:	John Ferguson
Project Initiated:	1984
Project Status:	Ongoing; scheduled to continue

Project Cost:

1986	51,359
1985	51,722
1984	4,976
TOTAL	108,057

Project Scope:

The Mid-Columbia smolt monitoring program is a cooperative effort between the P.U.D. No. 1 Chelan County (Chelan PUD), BPA, National Marine Fisheries Service (NMFS), and the Fish Passage Center. The program is designed to measure the migrational characteristics of outmigrating salmonids, and to provide a comparison and evaluation of year-to-year migrational information such as migration timing, travel time, and survival rates. Dates collected as a result of the program will be entered, processed, and stored on the NMFS centralized computer system at the Fish Passage Center. Monitoring at Rock Island Dam is ideal for indexing smolt movement and travel time because the trap site is located down river from the major tributaries and hatcheries of the mid-Columbia River.

Project Objectives:

1. Monitor marked and unmarked steelhead, coho, sockeye, and spring and summer chinook. Daily collections will be used to compute travel times, as well as the 10%, 50%, and 90% dates of passage at the site;

2. This information will allow for proper implementation of the Water Budget and spill programs;

3. Maintain the gatewell orifice bypass sampling system at Rock Island Dam; and

4. Data will be transmitted daily and will include:

   a. total number of each species of fish caught;

   b. total number of marked fish of each species caught;

c. total daily average riverflow; and

d. total daily average riverflow through Rock Island #l and Rock Island 112.

5. Annual report, completed by Oct. 15.

Project Results:

Each year the contractor has monitored the outmigration maintained the trap, collected and transmitted the appropriate data, and produced the annual report. Prior the the 1986 field season the trap was successfully modified to reduce holding turbulence and subsequent stress to the juvenile salmon and steelhead.

Project: Downstream Migrant Monitoring, BPA-86-60.

Program Measure: 304(d)

Contractor: National Marine Fisheries Service

Project Manager: John Ferguson

Project Initiated: 1986

Project Status: Ongoing and scheduled to continue

Project Cost: FY 1986 - $317,287

Project Scope:

This contract addresses two key elements of the Water Budget program:

1. Fish Passage Data Information System (FPDIS).

The primary purpose of the FPDIS is to provide a centralized collection, analysis and storage system for data used in implementing the Water Budget and downstream migration section of the Council's Program. The FPDIS is also used to provide a central source of fish migrational data to the general public. Water Budget managers and fishery managers use the data for in-season management decisions, as well as post-season analysis of the outmigration. The following management decisions take into consideration the FPDIS data:

a. the Water Budget;
b. spill for upstream and downstream migrations; and
c. spill distribution for nitrogen abatement.

2. Fish Marking Coordination.

The primary purpose of the fish marking coordination is to ensure that the fish needed to conduct the annual smelt monitoring program are requested from and approved by the participating agencies. Additionally, the time of marking and release, and the location of release are coordinated with the various entities.

Project Obiectives:

1. Fish Passage Data Information System

The FPDIS data is summarized weekly and provided to the Water Budget managers for incorporation into their weekly reports. The FPDIS data consists of the following:

a. smolt monitoring data;
b. smolt transportation data;
c. hatchery and freeze brand release data;
d. hydrologic data;
e. adult counts;
f. dissolved gas levels; and
Iii. water temperature data

The FPDIS also provides data for inclusion in the following:

a. the Water Budget manager's annual report, due November 1;

b. the annual smolt monitoring report for Project 84-14, due January 10; and

c. the Water Budget evaluation report, due November 1.

The FPDIS is scheduled to be made accessible to the project operators and the general public by late 1986.

2. Fish Marking Coordination

The objectives of the fish marking coordination task include:

a. Coordinating annual smolt monitoring fish marking efforts;

b. Monitor and report on brand quality, fish condition and length frequency;

c. Assure necessary raceways, equipment and facilities are provided to accomplish the task;

d. Prepare for the Water Budget Measures Program scopes of work for related field contracts for fish marking; and

e. Obtain schedules of hatchery and freeze brand releases for the FPDIS, and update weekly.

Project Results:

1. Fish Passage Data Information System

All objectives have been met in a timely manner to date. The equipment needed to make the FPDIS accessible to all parties has been purchased and tested. Computer programs are being written to finalize the process by the end of 1986.

2. Fish Marking Coordination

The marking has been well coordinated, conducted and monitored to date. Scopes of work that are prepared for the managers are complete and timely. Hatchery release schedules are thorough and updated weekly.

Project: Freeze Branding Salmon and Steelhead Trout at Lyons Ferry Hatchery, BPA-86-119.

Program Measure: 304(d)

Contractor: Washington Department of Fisheries

Project Manager: John Ferguson

Project Initiated: 1986

Project Status: Ongoing

Project Cost: FY 1986 - $7;128

Project Scope:

Washington Department of Fisheries, in cooperation with Washington Department of Game, mark steelhead trout, yearling chinook and subyearling chinook to monitor the smolt outmigration. The fish are freeze branded with liquid nitrogen. The numbers of fish branded are based on the following objectives:

1. Monitor smolt movement through recapture at various points in the hydrosystem;
2. Identify the effectiveness of the Water Budget and spill usage by collecting data on travel time, survival and adult returns;
3. Coordinate hatchery releases with Water Budget releases; and
4. Evaluate flow, spill and structural bypasses as a means of improving downstream migrant survival.

Project Objectives:

The specific objectives of this project are:

1. Mark 80,000 subyearling chinook, 40,000 yearling chinook, and 96,000 steelhead trout;
2. Perform quality control checks on all lots of fish marked to index brand quality and retention;
3. Provide steelhead passage (travel time) and survival data through the Lower Snake and Lower Columbia Rivers;
4. Provide chinook passage (travel time) data through the Lower Snake and Lower Columbia Rivers; and
5. Develop an annual report, due July 31.

Project Results:

In 1986 a total of 96,267 yearling steelhead, 40,294 yearling chinook and 81,158 subyearling chinook were freeze branded. Quality control chicks performed by Fish Passage Center personnel indicated no abnormal mortality rates or problems. All groups were released in a timely manner.

APPENDIX B

This Section lists reports summarizing results of projects implemented by BPA under Section 300 of the Columbia River Basin Fish and Wildlife Program. Copies of these reports can be obtained from: Bonneville Power Administration, Division of Fish and Wildlife - PJ, P.O. Box 3621, Portland, Oregon 97208.

Project 80-l

Fish Passage Center. 1986. Smolt Monitoring Program Annual Report 1985 Part I: Estimation of Survival. 1985 Annual Report. Fish Passage Center. Bonneville Power Administration - Project 80-l (DE-AI79-83BPll797-4).

Fish Passage Center. 1986. Smolt Monitoring Program Annual Report 1985. Part II: Migrational Characteristics of Columbia Basin Salmon and Steelhead Trout, 1985 Part I: Smolt Monitoring Program (Volume I). 1985 Annual Report. Fish Passage Center. Bonneville Power Administration - Project 80-l (DE-AI79-83BPll797-5).

Fish Passage Center. 1986. Smolt Monitoring Program Annual Report 1985. Part II: Migrational Characteristics of Columbia Basin Salmon and Steelhead Trout, 1985: Part II: Smolt Monitoring Program (Volume II) Brand Recapture Data. 1985 Annual Report. Fish Passage Center. Bonneville Power Administration - Project 80-l (DE-AI79-83BPll797-6).

Basham, L.R. 1985. Adult Fishway Inspections of the Columbia and Snake Rivers, 1984. 1984 Annual Report. Water Budget Center. Bonneville Power Administration - Project 80-l (DE-AI79-83BPll797-3).

McConnaha, W.E. and L.R. Basham. 1985. Survival of Wells Hatchery Steelhead in the mid-Columbia River, 1984. Part I: 1984 Smolt Monitoring Program Annual Report. 1984 Annual Report. Water Budget Center. Bonneville Power Administration - Project 80-l (DE-AI79-83BPll797-1)

Project 83-323

Scully, R.J. and E. Buettner. 1986. Smolt Condition and Timing of Arrival at Lower Granite Reservoir. 1985 Annual Report. Idaho Department of Fish and Game. Bonneville Power Administration - Project 83-323B (DE-AI79-85BP11631).

Project 83-491

Maher, M.W. and M.H. Karr. 1985. 1985 Annual Report from the Water Budget Managers. Bonneville Power Administration - Projects 83-491 and 83-536 (DE-AI79-85BPll639-2).

Northwest Power Planning Council. 1984. 1984 Annual Report from the Water Budget Managers. Bonneville Power Administration - Projects 83-491 and 83-536 (DE-AI79-84BPll639-2).

Project 84-14

Johnson, R.C. and C.L. Ranck. 1985. Monitoring of downstream salmon and steelhead at Federal hydroelectric facilities - 1985. 1985 Annual Report. National Marine Fisheries Service, Environmental and Technical Services Division, Portland, Oregon. Bonneville Power Administration - Project 84-14. (DE-AI79-85BP20733).

Project 84-17

Nelson, L.V. 1986. Freeze brand marking of Steelhead trout and Chinook salmon juveniles for Water Budget studies: Idaho. 1985 Annual Report. Idaho Department of Fish and Game. Bonneville Power Administration - Project 84-17 (DE-AI79-84BP16440).

Project 84-54

Truscott, K. 1985. Juvenile Salmonid Monitoring at Rock Island Dam Bypass Sampler. 1985 Annual Report. Public Utility District No. 1 of Chelan County. Bonneville Power Administration - Project 84-54 (DE-AI79-85BP22311-1).

MMaher:5624:rsr (PJI-9658N)